ASSESSMENT OF THE POLAR BEAR POPULATION IN THE EASTERN BEAUFORT SEA

Ian Stirling, Dennis Andriashek, Cheryl Spencer,
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Progress report to the
Northern Oil and Gas Action Program
by Canadian Wildlife Service, Edmonton, Alberta

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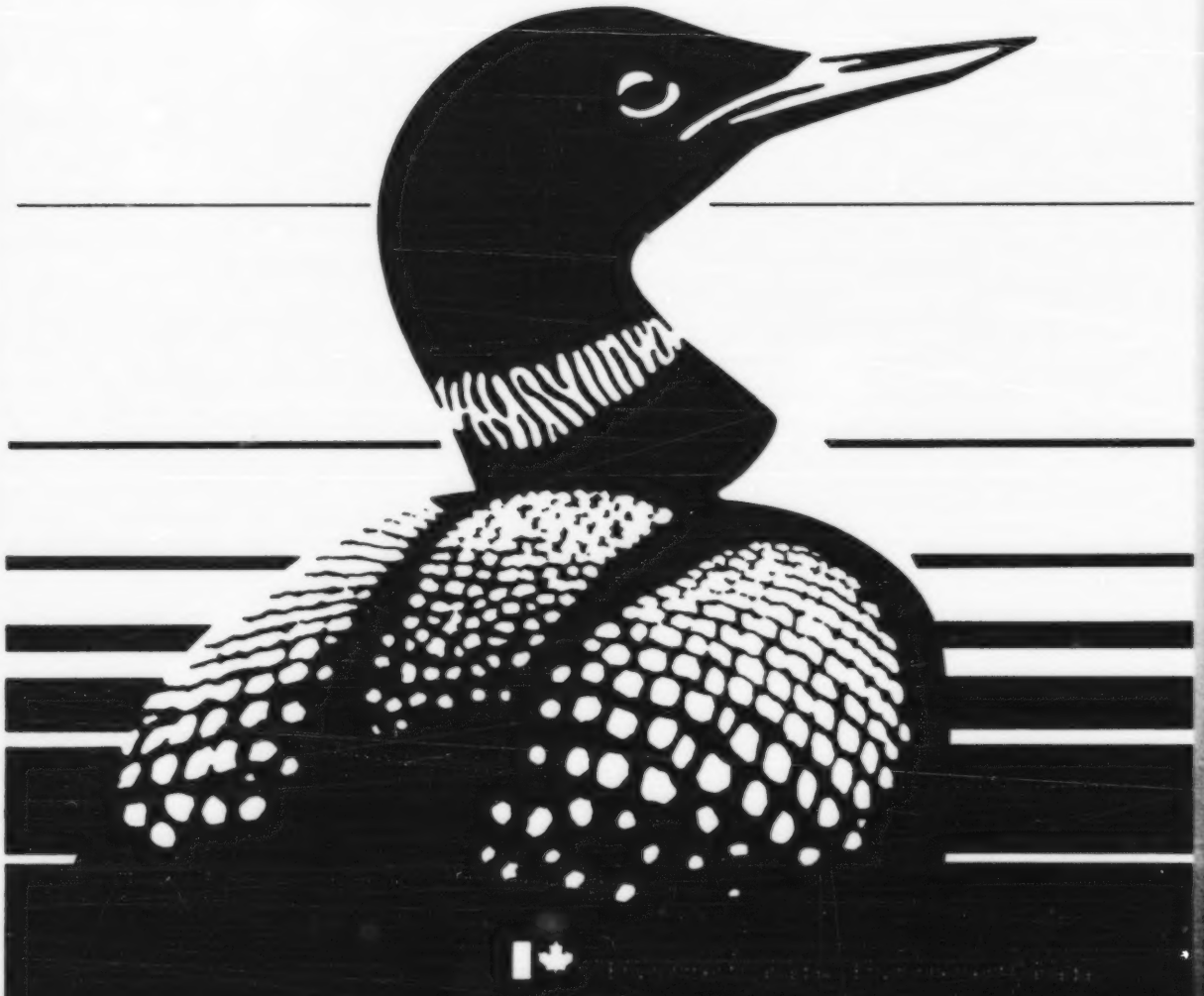

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ABSTRACT

The study area for this project is the Beaufort Sea east of 141° W and south of 75° N, and Amundsen Gulf. The objectives are to determine the present size of the population of polar bears in the study area, and their vital parameters, compare these results with data collected in the 1970s, and, if possible, evaluate the effects of offshore hydrocarbon exploration and production on polar bears. In 1985 and 1986, 406 individual polar bears were tagged. No deaths were caused by the drugging and handling procedures. Preliminary examination of movement data continue to indicate a separation of the polar bear population along the mainland coast from that on the west coast of Banks Island and Amundsen Gulf. The average ages of males and females one year of age or greater were 7.01 and 7.43 for males and females respectively. Of the 191 males and 215 females handled, 45 (23.7%) and 57 (26.5%) were 10 years of age or greater.

The mean litter size of cubs of the year was 1.94. Age specific natality rates were comparable to values calculated in the study area from 1971-79. Estimates of sex-specific annual survivorship, calculated from the combined 1985 and 1986 age structures, ranged from 87.0% to 88.5%. Preliminary estimates of population size in the study area in 1986, calculated from related data sets are 1373 $\pm$ 274 (SD) and 1459 $\pm$ 392 (SD). These estimates are lower, though probably not significantly so, than estimates made in the late 1970s. The present harvest is probably at maximum sustainable yield.

Determination du nombre d'ours polaires dans la partin est de la mer de Beaufort

RÉSUMÉ

Lâ région étudiés dans la cadra de ce projet se situs dans la mer da Beaufort, à l'est du 141° de longitude O. et au sud du 75° da latitude N. et dans le golfe Amundsen. L'étude a comme objactif de déterminer la nombre d'ours polaires qui habitent actuellement la région visée, d'établir leure paramètres vitaux, da comparer las résultats obtenue avec les données recueillies pendant les années 1970 et, si possible, d'évaluer les répercussions qu'ont l'exploration et la production d'hydrocarbures au large des côtes sur les ours polaires. En 1985 et an 1986, 406 ours polaires ont reçu une plaque d'identité. L'administration de droque et les procédures de manutention des animaux n'ont causé aucun décés. Salona une étude préliminaire données portant sur les déplacements, tout semble encore indiquer oua la population d'ours polaires le long de la côte principale est distincte de celle de la côte ouest de l'tle Banks et du golfe Amundsen. L'âge moyen des ours polaires d'un an ou plus était de 7,01 et 7,43 san pour les mâles et les femelles respectivement. L'âge moyen des mâles et des femelles âgés d'un ou plus était de 7,01 et de 7,43 ans. Parmi les 191 mâles et les 215 femelles identifiés, 45 (23,7%) et 57 (26,5%) respectivement étaient âgés de 10 ans ou plus.

Le nombra moyen d'oursons par portée a'élevait pour cette année à 1,94. Les taux de natalité établis pour divers groupes d'âges particuliers étaient comparables à ceux qui ont été établis dans la région étudiés de 1971 à 1973 ou de 1977 à 1979. Les taux annuels de survie, distincts pour les mâles et les femelles, calculés selon les structures par âge combinées de 1985 et de 1986, varient de 87 % à 88.5 %. Selon des estimations préliminaires, le nombre d'ours polaires dans la région étudiée en 1986 a été évalué. à partir d'ensembles de données connexes, à 1 373 + 274 (écart-type) et à 1 459 + 392 (écart-type). Ces données estimatives sont inférieures à celles qui ont été établies à la fin des années 1970, sans que la différence ne soit probablement significative. La population actuelle d'ours polaires a probablement atteint son rendament maximal équilibré.

INTRODUCTION

From 1971 through 1979, the Canadian Wildlife Service studied the population ecology of the polar bear (Ursus maritimus) in the eastern Beaufort Sea and Amundsen Gulf (hereafter referred to as the Western Arctic). The initial objective of this project was to assess the size, distribution, and demographic and reproductive parameters of the polar bear population to provide a biological basis for management decisions to be made by the Government of the Northwest Territories. The original project was intended to run for 5 years. However, between 1974 and 1975, the population of polar bears decreased significantly and its reproductive rate dropped by about one-half. While on one hand, this sudden change made interpretation of the data collected between 1971 and 1975 more difficult, it also represented an unusual research opportunity. It was decided that continued monitoring of polar bear numbers and reproductive parameters might give some idea of the minimum time required for a population to recover if a similar decline resulted from a man-made disaster, such as an uncontrolled oil blowout, that caused additional environmental damage. Thus, monitoring continued for an additional four years (1976-1979). Unfortunately, because of insufficient funds, the monitoring phase was not conducted at the same level as the previous studies. Although several reports have been published from this project (Stirling et al. 1975, 1976, 1981), the final report is still being completed.

In the 10 years that have passed since the mark and recapture studies were conducted in the mid-1970s, there have been several significant developments. In 1978, on the basis of the population

studies completed to that time, the harvest quota for the Western Arctic (Zone H) was increased by 20 bears (26%) to 97. It is presently 103. There has been considerable offshore exploration for hydrocarbons involving drill-ships, icebreakers, shore bases, artificial islands, and semi-permanent but moveable offshore drilling platforms. Much of this activity has taken place in the best polar bear habitat but the possible effects on polar bears have not been evaluated. We do know however that polar bears are sometimes attracted to offshore rigs and seismic trains and occasionally are shot to protect human life or property. Beginning in 1972, with the passage of the U.S. Marine Mammal Protection Act, there have been no restrictions of any kind on the taking of polar bears by indigenous people in Alaska for subsistence purposes. The size of the take has varied between years (Schliebe 1986) but it appears to have been concentrated on subadults and family groups. Research has now shown that the polar bear population along the mainland coast from about Point Barrow in Alaska to Baillie Islands in Canada is shared by the two countries (Amstrup et al. 1986). Because there are no quotas in Alaska at present, the potential exists for a substantial overharvest.

The Northern Oil and Gas Action Program (NOGAP) was established to advance the state of governmental preparedness for hydrocarbon development in the north. Studies were to look at potential impact from development of offshore and onshore hydrocarbon resources and the transportation of those resources by either tankers through the High Arctic or by a Mackenzie Valley Pipeline. This study of the present status of the polar bear population in the Western Arctic is

being conducted as part of the overall environmental program being funded by NOGAP.

OBJECTIVES

The primary objectives of this study are as follows:

1. determine the present size of the population, demographic and reproductive parameters, and distribution of subpopulations in the Western Arctic;
2. compare the results obtained in this study with those obtained between 1971 and 1979; and,
3. if possible, evaluate whether or not offshore exploration for hydrocarbons has had detectable effects on polar bears.

It will be difficult to meet the requirements of objective 3. In part, this is because of the problem of establishing cause and effect relationships without an experimental procedure. As a result, most evaluations will be speculative judgements based on the data collected, our years of experience with polar bears, and any other related information we can obtain. In addition, because of the confounding influence of the increased quotas in Canada and the unrestricted (and variably recorded) harvest practices in Alaska, it will be difficult if a significant change (positive or negative) is detected in the polar bear population, to be sure that it could have resulted from the effects of offshore activity.

MATERIALS AND METHODS

The study area was defined as the Beaufort Sea east of 141°W and south of 75°N, and Amundsen Gulf (Fig. 1). The methods and rationale for tagging and recapture of individual bears, calculation of reproductive values, collection of specimens from Inuit hunters, and age determination, survivorship, and population estimation were the same as described by Chapman and Robson (1960), DeMaster et al. (1980), Stirling et al. (1975, 1980).

In 1985, 158 bears were immobilized with Rompun and Ketamine followed by the use of the antagonist Yohimbine (Ramsay et al. 1985). An additional twenty bears were immobilized with Telazol (Haigh et al. 1985; Stirling et al. 1985) in order to test its effectiveness under cold weather conditions. In 1986, all bears handled were immobilized with Telazol.

In 1985, radio collars for a telemetry study of seasonal movements and maternity denning were attached to 27 adult female polar bears, 14 of which were east of the northern tip of the Cape Bathurst Peninsula (Stirling et al. 1986, Fig. 2). These bears were relocated at approximately monthly intervals by S. Amstrup, U.S. Fish and Wildlife Service, who will report the results of that study separately.

Field work was conducted between 11 April and 28 May in 1985 and between 15 April and 16 May in 1986. Two Bell 206B Jetranger helicopters were used in each year during most but not all of the survey periods. This enabled us to maintain the sampling effort over much of the study area simultaneously and hopefully reduces sampling

bias. Although it was not always possible because of limitations of fuel or weather, we attempted to capture all bears sighted.

RESULTS AND DISCUSSION

Number of bears captured

In 1985 and 1986, we captured 178 and 228 polar bears respectively (Figs. 1 and 2). An additional number of polar bears were tagged between Tuktoyaktuk and Herschel Island as part of the radio-tracking study. Some of these data may be useable in this study but we have not yet been able to evaluate the information.

Movements

Thirty-eight of the bears recaptured in 1985 and 1986 were originally caught between 1971 and 1979. Figure 3 shows where those bears were recaptured in relation to where they were originally caught. Twenty-six of the bears caught in 1985 were recaptured in 1986 (Fig.4). From inspection, these results continue to indicate a fairly high degree of seasonal fidelity and a separation of bears on the west coast of Banks Island from those along the mainland coast.

Reproductive rates

The mean litter size of cubs of the year in 1985 and 1986 was 2.00 (SE = 0.12, n = 8) and 1.90 (SE = 0.10, n = 10) respectively. These mean litter sizes are similar to what was recorded in the Beaufort Sea in 1977-79. Mean litter sizes of yearling and 2-year-old cubs with their mothers (Table 2) were comparable to what has been recorded in past years.

Age-specific natality rates calculated from the 1986 data on females and cubs (Table 4b) were lower than were reported from 1971-73, 1977-79, or 1985, but were comparable to 1974-76. In 1985, the litter produced rate for adult females (aged 5-31) accompanied by COY was 0.22 compared to 0.37 for females with yearlings, which probably indicates an undersampling of females with COY, as has been noted in past years. However, in 1986, the litter-produced rates for adult females (aged 5-28) accompanied by COY and yearlings were 0.16 and 0.18 respectively, values which are almost identical and both of which are much lower than in 1985. These results do not indicate that females with COY were undersampled in relation to females accompanied by yearlings in 1986 but they may indicate that production of cubs and/or survival of litters was lower. The reason for this change is not known at present. However, in 1986, there was a very high proportion of multiyear ice throughout the southern Beaufort Sea and Amundson Gulf. The distribution of females with COY was different from that reported in any previous years. In 1986, for the first time, no females with COY were captured on the west coast

of Banks Island, and conversely, for the first time, most were caught in the general area to the north and east of Baillie Islands.

The age at which females first breed (ie. conceive) is still five years (Table 4b). This is the same as it was in the eastern Beaufort Sea from 1971-79 and from the Alaskan coast through a similar period of time (Stirling et al. 1975; Lentfer et al. 1980). This contrasts with female polar bears along the Manitoba coast of Hudson Bay or the Central, Eastern, and High Arctic where first breeding occurs one year earlier (Stirling et al. 1978; 1980; 1984; Schweinsburg et al. 1981; Ramsay and Stirling 1982).

Age Structure

A total of 178 polar bears (79 males, 99 females) were captured throughout the study area in 1985 (Stirling et al. 1986, Table 1, Fig. 1). In 1986, 228 polar bears (112 males and 116 females) were captured (Table 1, Fig. 2). There were no handling deaths.

The average ages (±SE) of males and females, one year of age or greater in 1985, were 6.61 ± 0.59 yr (n = 71) and 7.03 ± 0.71 yr (n= 90) respectively and 9.44 ± 0.75 yr (n = 41) and 11.93 ± 1.01 yr (n = 44) respectively for males and females 5 years or more of age. The average ages (±SE) of males and females one year of age or greater in 1986, were 7.29 ± 0.52 yr (n=103) and 7.77 ± 0.58 yr (n=106) respectively, and 10.42 ± 0.59 yr (n=62) and 10.96 ± 0.66 yr (n=67) respectively for males and females 5 years or more of age.

The portion of males and females 10 years of age or older in 1985 was 20.3% (16/79) and 24.2% (24/99) respectively, and 25.9% (29/112) and 28.4% (33/116) respectively in 1986. The portion of males and females 10 years of age or older (both years combined) was 23.7% (45/191) and 26.5% (57/215) respectively. These values are quite similar to those reported by Stirling et al. (unpublished) for polar bears in the study area in the late 1970s, by which time survival rates had improved from possibly lower values in the early 1970s.

Another result that also suggests that survival of polar bears has been high over the past few years is the number of polar bears we recaptured that had been tagged in the original study done between 1971 and 1979. 23 bears were recaptured in 1985. Of the bears captured that were old enough ($\geq$ 7 yr) to have been captured in 1979 or earlier, 9/26 (34.6%) of the males and 11/30 (36.7%) of the females were recaptures. Of these 20 recaptures, 3 of the first captures occurred in the fall and 1 in the summer. 1 bear was first captured in 1983 and 2 bears were recaptured but first capture was unknown. 44 bears were recaptured in 1986. Of the bears captured that were old enough ($\geq$ 8 yr) to have been captured in 1979 or earlier, 9/38 (23.7%) of the males and 9/45 (20.0%) of the females were recaptures. The first capture of 2 of these bears (2/18) occurred outside of the spring capture season in November and July, respectively. 2 bears were first captured in 1983. 26 bears recaptured in 1986 were captured in 1985, and of these 2 bears were first captured in the 1971-79 sampling effort.

In the age structures of the capture and kill samples from 1971-79 and 1971-83 respectively, the cubs born in 1971-73 and 1977-79 represent consistently strong cohorts (Stirling et al. unpublished data). In contrast, the cohorts from 1974-76, during which cub production was markedly lower and survival probably was lower as well, are consistently underrepresented. That effect appears to weaken slightly by the early 1980s but our ability to follow such a change is weakened by the smaller sample sizes in the latter years.

Thus, it is of particular interest to note that in the 1985 sample, the cohorts of 1971-73, 1974-76, and 1977-79 were 3.9%, 6.2%, and 11.8% respectively of the total sample. In the 1986 sample, the cohorts of 1971-73, 1974-76, and 1977-79 represented 7.5%. 8.8%, and 15.4% respectively of the total sample. These proportions are similar to what might be expected in a normal unperturbed age structure. Although great caution should be exercised in interpreting these preliminary results, they may indicate that the underrepresented ages in the population have been replaced by immigration. If true, this result is of great importance to assessing the potential for recovery of polar bear populations that have been significantly reduced in numbers by natural or unnatural causes. In this case, it appears that the return to a normal age structure, after the decline in numbers and productivity of the 1974-76 period, has taken about 10 years. Further speculation is clearly unwarranted but the importance of this result is such that we wish to note it for further attention.

Survivorship

Annual rates of survivorship of male and female polar bears were calculated from the combined 1985 and 1986 age structures (Table 1) by the method of Chapman and Robson (1960). Calculations were made over age classes that both segregated and pooled subadults and adults (Table 5). It is interesting to note that regardless of the sex or range of age classes chosen, all of the survivorship values determined, except one (85.6% for 5 to 25-year-old males), were between 87.0% and 88.5%. We recognise that the calculation of annual survivorship from age structure assumes a stable age distribution and that we do not know if this assumption is true. However, in a species like the polar bear, we suspect that changes in the composition of the sex-specific age structure likely occurs at a slow enough rate that our approximation of overall annual mortality rate by the Chapman and Robson (1960) method is probably generally reflective of reality. These annual survivorship rates are similar to those calculated for other populations using an exponential decay curve (Stirling et al. 1976, 1980, 1984; Furnell and Schweinsburg 1984). It should also be noted that the survivorship values calculated by this method already include mortality resulting from the annual Inuit harvest.

Population estimation

There are two related data sets with which an estimation of population size can be made using the method of DeMaster et al. (1980). The first is to use only the 1985 and 1986 data. The second is to estimate the number of marks surviving from the 1971-79 period, plus the small 1983 sample, which allows a population estimation to be made in both 1985 and 1986. Using just the 1985 and 1986 data, we estimated a population in the study area of 1373 ± 274 (SD). Using an estimate of the number of marks surviving to 1985 from the 1971-79 and 1983 samples, we estimated a population of 1442 ± 554 (SD) and 1459 ± 392 (SD) in the study area in 1985 and 1986 respectively. These estimates are smaller but probably not significantly different from that of the late 1970s of about 1,800, based on much smaller sample sizes. However, these values underscore concern that the existing harvest in Canada and Alaska is already at, if not possibly slightly over the maximum that is sustainable, especially when problem kills are considered as well. If harvest at this level is to continue, it will be important to minimize the harvest of adult females.

FUTURE PLANS

Field work and laboratory analyses

The mark and recapture effort will be repeated during April and May of 1987, using the same methods as in 1985 and 1986. The tagging effort will again be spread over the entire study area and all habitat types will be searched. The minimum acceptable sample size needed to use the DeMaster et al. (1980) mark and recapture estimate technique is 120 although it is clearly more desirable to capture in excess of 150.

The age of all captured bears will be determined in the laboratory from premolar teeth collected in the field. The age of each tooth will be determined twice to ensure maximum accuracy. Age and sex-specific reproductive parameters will be calculated from the final samples pooled for the three years of the study.

Since no funds are available in 1988-89 to facilitate final clean up of fuel drums after completion of field work, it may be desirable to earmark unused year-end funds (1987-88) from the overall NOGAP program for final clean-up.

Final Report

The final report will contain the analyses of all data collected by us during the three years of the study. In order to maximize our ability to meet all the objectives listed on p. 3, we plan to include as much as possible from the following in the final report:

1) mark and recapture data on polar bears captured within the study area by Biologists and Conservation Officers from the Yukon Wildlife Branch, NWT Wildlife Service, and U.S. Fish and Wildlife Service: Some of these data were collected with NOGAP funds allocated to the Yukon for polar bear research. Some of these bears may have been captured in such a way as to qualify for inclusion in the marked sample for population estimates. Their inclusion will have the desirable effect of increasing sample size. We are still trying to determine which data may be included;

2) results of ongoing radio-tracking studies on adult female polar bears: The lead agency in this research has been the U.S. Fish and Wildlife Service but considerable technical and financial support has also been provided by NOGAP, CWS, and NWTWS. These data should be of particular importance in helping to define the two apparent subpopulations in the study area. The results may also affect the way the population estimates are made;

3) other scientific publications and data available on polar bears from other areas: These results will be incorporated where relevant in order to maximize the scientific value of the results from the research conducted;

4) data from the wildlife observation forms maintained by the offshore rigs: There is a considerable base of data here which is relevant to objective 3 of this study; and

5) data from the Inuit harvest of polar bears: The age compostion of bears killed by Inuit hunters will be analyzed in relation to the capture sample if the data can be made available in time. Particular attention will be paid to the previous movement

history of marked bears killed by Inuit hunters in order to evaluate the degree to which each settlement depends upon either of the two apparent subpopulations in the study area. From this analysis, we would hope to be able to predict what settlements might be impacted by different sorts of man-made perturbations on the ecosystem that might influence polar bears.

ACKNOWLEDGEMENTS

We are grateful to the following organizations for support: NOGAP, Canadian Wildlife Service, Northwest Territories Wildlife Service, Yukon Game Branch, and the Polar Continental Shelf Project. The following gave us invaluable assistance in the field: S. Amstrup, P. Esau, E. Henderson, K. John, J. Lee, J. Lucas, E. Pokiak, P. Voudrach, and B. Smith. W. Calvert and M. Nietfield assisted with laboratory analyses and computing. S. Popowich assisted with the figures. S. Fleck and G. Holroyd reviewed the manuscript.

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Table 1. Age structure of polar bears captured or recaptured in April and May 1985 and 1986 in the Eastern Beaufort Sea.

Age	1985 Sex of bears captured		1986 Sex of bears captured		1985-1986 Sex of bears captured	
	male	female	male	female	male	female
0	7	9	9	10	16	19
1	8	13	12	9	20	22
2	3	15	7	15	10	30
3	8	7	9	9	17	16
4	11	11	13	6	24	17
5	12	9	7	6	19	15
6	3	5	8	11	11	16
7	4	3	9	5	13	8
8	4	2	5	7	9	9
9	2	1	4	5	6	6
10	4	2	3	6	7	8
11	1	1	6	3	7	4
12	-	3	1	1	1	4
13	1	1	-	1	1	2
14	2	-	2	4	4	4
15	3	4	5	5	8	9
16	1	3	5	4	6	7
17	-	1	2	3	2	4
18	2	2	-	-	2	2
19	-	1	2	1	2	2
20	1	-	2	1	3	1
21	-	2	1	1	1	3
22	1	1	-	-	1	1
23	-	-	-	-	-	-
24	-	1	-	1	-	2
25	-	1	-	-	-	1
26	-	-	-	1	-	1
27	-	-	-	-	-	-
28	-	-	-	1	-	1
29	-	-	-	-	-	-
30	-	-	-	-	-	-
31	-	1	-	-	-	1
unaged	1	-	-	-	1	-
Total	79	99	112	116	191	215

Table 2. Mean litter size of cubs of different ages captured in the Eastern Beaufort Sea, April and May, 1985.

Age of cubs	Mean litter size	95% confidence interval	Sample size
Cubs of the year	2.00	±0.447	8
Yearling	1.54	±0.314	13
2-year old	1.67	±1.43	3

Mean litter size of cubs of different ages captured in the Eastern Beaufort Sea, April and May, 1986.

Age of cubs	Mean litter size	95% confidence interval	Sample size
Cubs of the year	1.90	±0.226	10
Yearling	1.50	±0.332	12
2-year old	1.40	±0.369	10

Mean litter size of cubs of different ages captured in the Eastern Beaufort Sea, April and May, 1985-1986.

Age of cubs	Mean litter size	95% confidence interval	Sample size
Cubs of the year	1.94	± 0.207	18
Yearling	1.52	± 0.211	25
2-year old	1.46	± 0.314	13

Table 3a. Age and litter size of cubs accompanying female polar bears of each age class captured in the Beaufort Sea in April and May, 1985.

Age	Females		Age and litter size of cubs accompanying female						
	Total caught	No. with cubs of any age	Cubs of year			Yearlings		2-year old	
			1	2	3	1	2	1	2
3	7	-	-	-	-	-	-	-	-
4	11	-	-	-	-	-	-	-	-
5	9	2	-	-	-	2	-	-	-
6	5	3	1	2	-	-	-	-	-
7	3	1	-	-	-	1	-	-	-
8	2	2	-	-	-	2	-	-	-
9	1	1	-	1	-	-	-	-	-
10	2	1	-	-	-	-	-	-	1
11	1	-	-	-	-	-	-	-	-
12	3	2	-	1	-	1	-	-	-
13	1	1	-	-	-	-	-	1	-
14	-	-	-	-	-	-	-	-	-
15	4	4	-	-	-	-	4	-	-
16	3	3	-	1	-	-	2	-	-
17	1	1	-	-	-	-	1	-	-
18	2	1	-	-	-	-	-	-	1
19	1	1	-	-	1	-	-	-	-
20	-	-	-	-	-	-	-	-	-
21	2	1	-	1	-	-	-	-	-
22	1	-	-	-	-	-	-	-	-
24	1	-	-	-	-	-	-	-	-
25	1	-	-	-	-	-	-	-	-
31	1	-	-	-	-	-	-	-	-

Table 3b. Age and litter size of cubs accompanying female polar bears of each age class captured in the Beaufort Sea in April and May, 1986.

Age	Females		Age and litter size of cubs accompanying female						
	Total caught	No. with cubs of any age	Cubs of year			Yearlings		2-year old	
			1	2	3	1	2	1	2
3	9	-	-	-	-	-	-	-	-
4	6	-	-	-	-	-	-	-	-
5	6	-	-	-	-	-	-	-	-
6	11	4	1	-	-	2	1	-	-
7	5	2	-	-	-	-	1	1	-
8	7	4	-	1	-	1	1	-	1
9	5	4	-	2	-	2	-	-	-
10	6	4	-	1	-	-	1	1	1
11	3	1	-	1	-	-	-	-	-
12	1	1	-	-	-	-	-	1	-
13	1	1	-	-	-	-	1	-	-
14	4	3	-	-	-	-	1	1	1
15	5	2	-	2	-	-	-	-	-
16	4	3	-	1	-	-	-	2	-
17	3	2	-	-	-	1	-	-	1
18	-	-	-	-	-	-	-	-	-
19	1	-	-	-	-	-	-	-	-
20	1	-	-	-	-	-	-	-	-
21	1	1	-	1	-	-	-	-	-
24	1	-	-	-	-	-	-	-	-
26	1	-	-	-	-	-	-	-	-
28	1	-	-	-	-	-	-	-	-

Table 3c. Age and litter size of cubs accompanying female polar bears of each age class captured in the Beaufort Sea in April and May, 1985-1986.

Age	Females		Age and litter size of cubs accompanying female						
	Total caught	No. with cubs of any age	Cubs of year			Yearlings		2-year old	
			1	2	3	1	2	1	2
3	16	-	-	-	-	-	-	-	-
4	17	-	-	-	-	-	-	-	-
5	15	2	-	-	-	2	-	-	-
6	16	7	2	2	-	2	1	-	-
7	8	3	-	-	-	1	1	1	-
8	9	6	-	1	-	3	1	-	1
9	6	5	-	3	-	2	-	-	-
10	8	5	-	1	-	-	1	1	2
11	4	1	-	1	-	-	-	-	-
12	4	3	-	1	-	1	-	1	-
13	2	2	-	-	-	-	1	1	-
14	4	3	-	-	-	-	1	1	1
15	9	6	-	2	-	-	4	-	-
16	7	6	-	2	-	-	2	2	-
17	4	3	-	-	-	1	1	-	1
18	2	1	-	-	-	-	-	-	1
19	2	1	-	-	1	-	-	-	-
20	1	-	-	-	-	-	-	-	-
21	3	2	-	2	-	-	-	-	-
22	1	-	-	-	-	-	-	-	-
24	2	-	-	-	-	-	-	-	-
25	1	-	-	-	-	-	-	-	-
26	1	-	-	-	-	-	-	-	-
28	1	-	-	-	-	-	-	-	-
31	1	-	-	-	-	-	-	-	-

Table 4a. Age-specific litter-produced rates, litter sizes, and natality rates of female polar bears in the Eastern Beaufort Sea, 1985. (Sample sizes are in parentheses.)

Age class of females (yrs)	Age-specific litter-produced rate (no. of females)	Age-specific mean litter size (no. of litters)	Age-specific natality rate
3	0.10 (20)	1.00 (2)	0.100
4	0.00 (14)	0.00 (1)	0.000
5	0.50 (8)	1.50 (4)	0.750
6-9	0.21 (14)	1.50 (4)	0.315
10-14	0.40 (20)	1.78 (9)	0.712
15-19	0.23 (13)	2.25 (4)	0.518
20-31	0.10 (10)	2.00 (1)	0.200
5-31	0.29 (65)	1.77 (22)	0.513

Table 4b. Age-specific litter-produced rates, litter sizes, and natality rates of female polar bears in the Eastern Beaufort Sea, 1986. (Sample sizes are in parentheses.)

Age class of females (yrs)	Age-specific litter-produced rate (no. of females)	Age-specific mean litter size (no. of litters)	Age-specific natality rate
3	0.00 (12)	0.00 (0)	0.000
4	0.18 (17)	1.25 (4)	0.225
5	0.13 (16)	1.67 (3)	0.217
6-9	0.21 (44)	1.58 (12)	0.332
10-14	0.17 (29)	1.70 (10)	0.289
15-19	0.13 (15)	1.50 (2)	0.195
20-28	0.14 (7)	2.00 (1)	0.280
5-28	0.17 (111)	1.64 (28)	0.279

Table 4c. Age-specific litter-produced rates, litter sizes, and natality rates of female polar bears in the Eastern Beaufort Sea, 1985-1986. (Sample sizes are in parentheses.)

Age class of females (yrs)	Age-specific litter-produced rate (no. of females)	Age-specific mean litter size (no. of litters)	Age-specific natality rate
3	0.06 (32)	1.00 (2)	0.060
4	0.10 (31)	1.25 (4)	0.125
5	0.25 (24)	1.57 (7)	0.393
6-9	0.21 (58)	1.56 (16)	0.328
10-14	0.27 (49)	1.74 (19)	0.470
15-19	0.18 (28)	2.00 (6)	0.360
20-31	0.12 (17)	2.00 (2)	0.240
5-31	0.22 (176)	1.70 (50)	0.374

Table 5. Sex-specific annual survival rates of polar bears, calculated from the combined 1985 and 1986 age structure by the Chapman and Robson (1960) method.

SEX	AGE RANGE OVER WHICH CURVE FITTED	MEAN SURVIVAL RATE	STANDARD DEVIATION
male	0 - 25	0.881	0.010
male	2 - 25	0.870	0.013
male	5 - 25	0.856	0.018
male	5 - 20	0.876	0.021
female	0 - 25	0.883	0.010
female	2 - 25	0.872	0.012
female	5 - 25	0.882	0.016
female	5 - 20	0.885	0.020

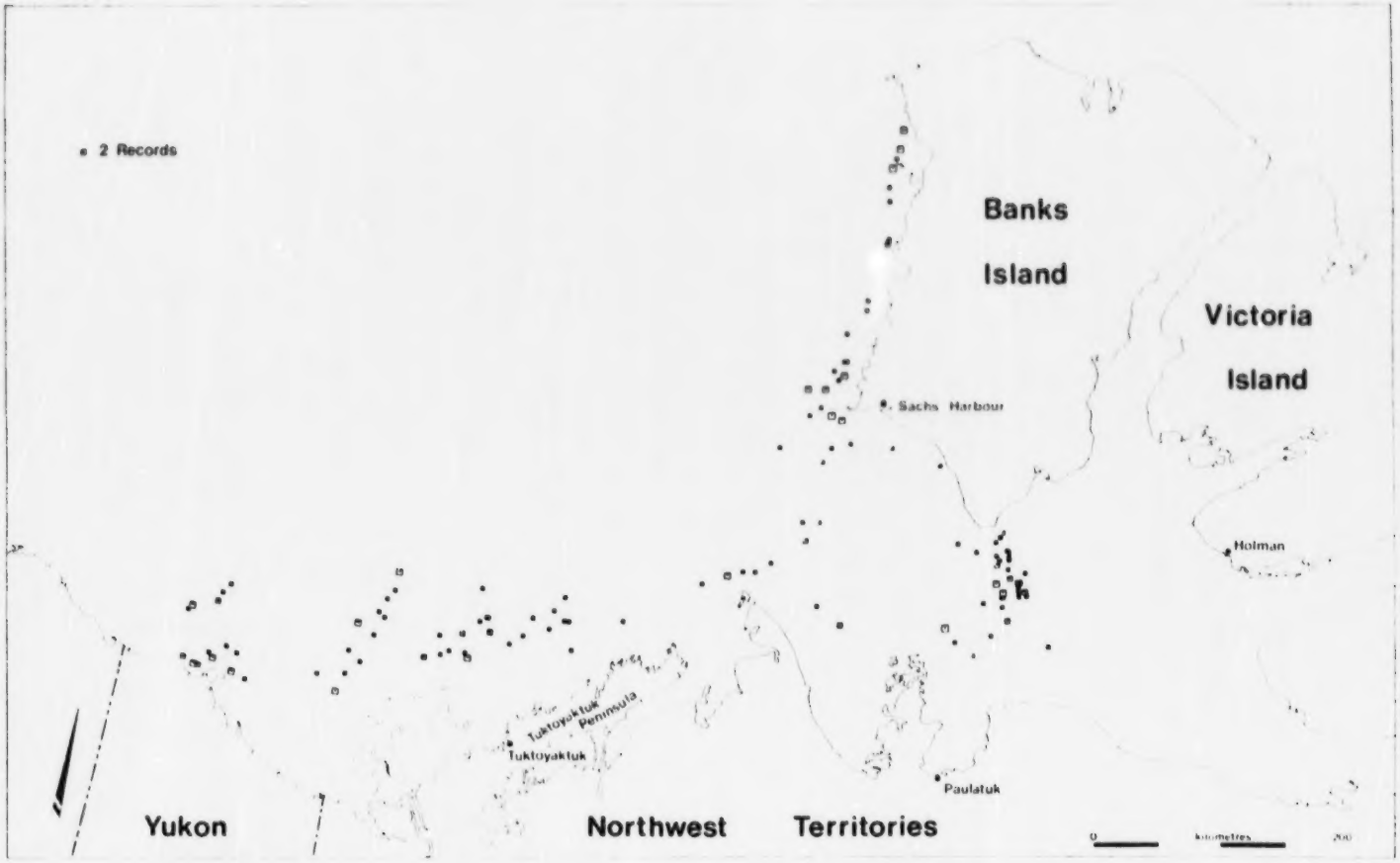

Figure 1. Location at which polar bears were captured in the eastern Beaufort Sea and Amundsen Gulf in April and May, 1985.

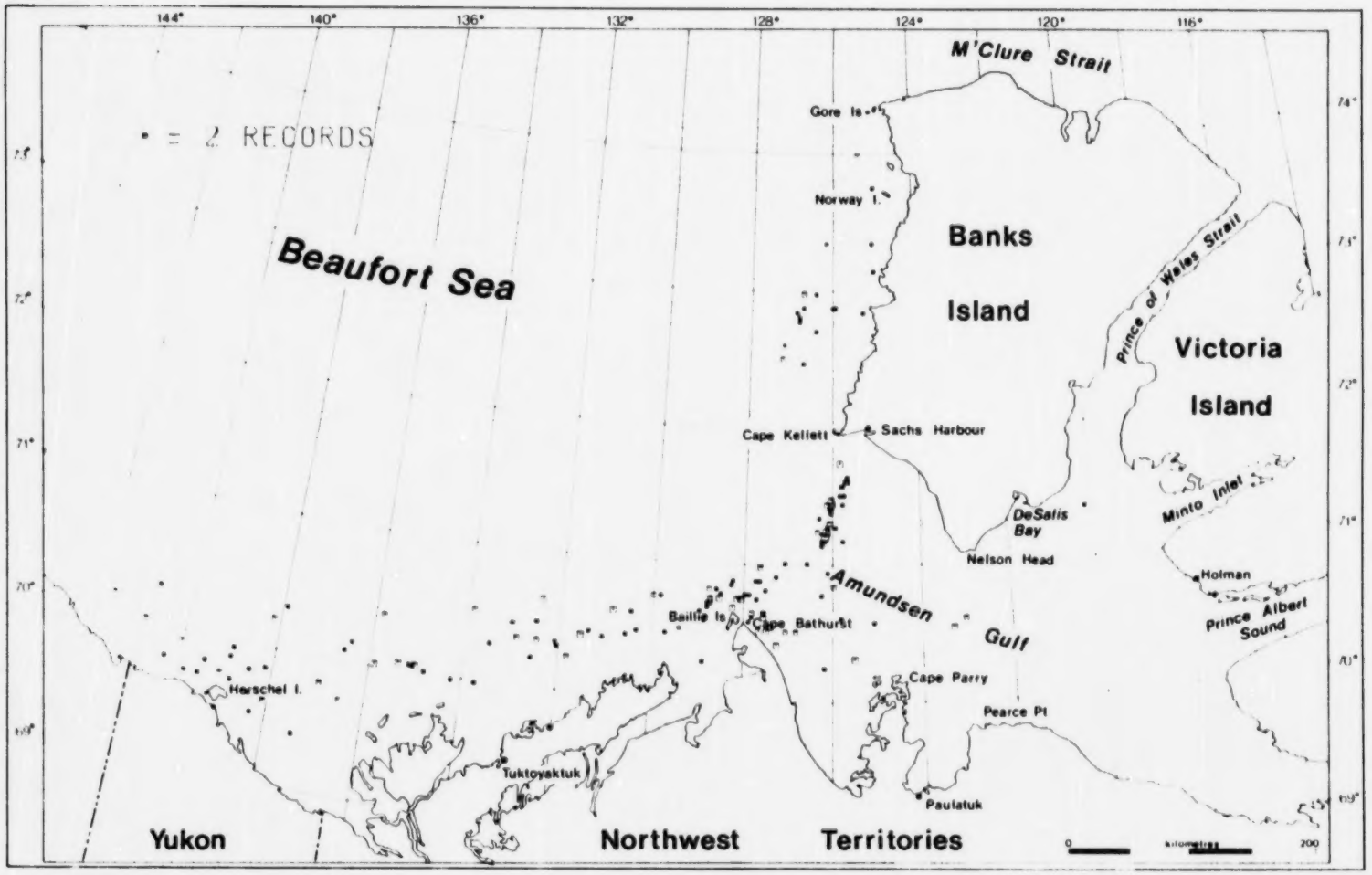

Figure 2. Locations at which polar bears were captured in the eastern Beaufort Sea and Amundsen Gulf in April and May, 1986.

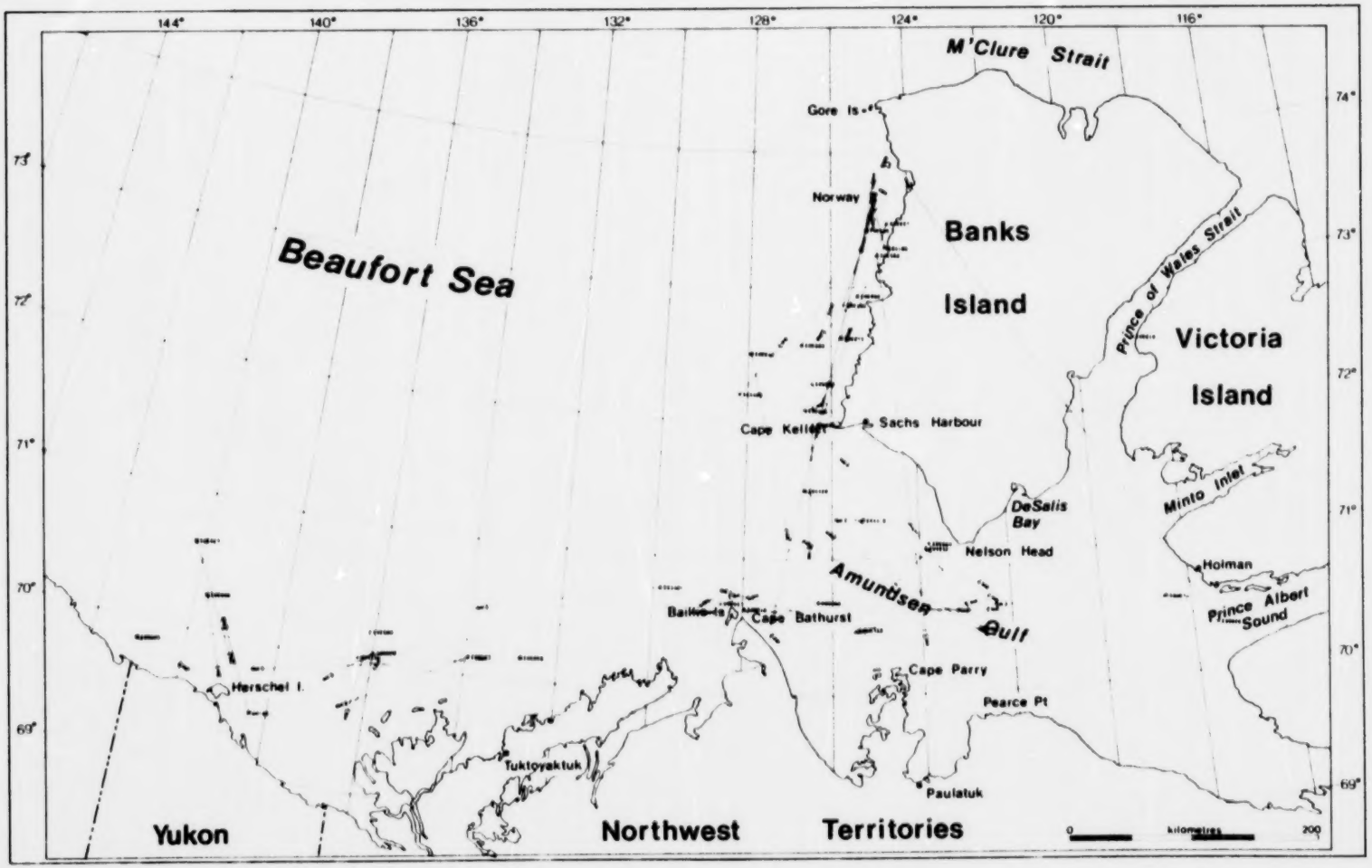

Figure 3. Movements of polar bears first captured in the eastern Beaufort Sea and Amundsen Gulf between 1971 and 1979 and recaptured in 1985 and/or 1986. (Most recent recapture is either 1985 or 1986 and is not distinguished on figure). (includes first capture outside of spring tagging season).

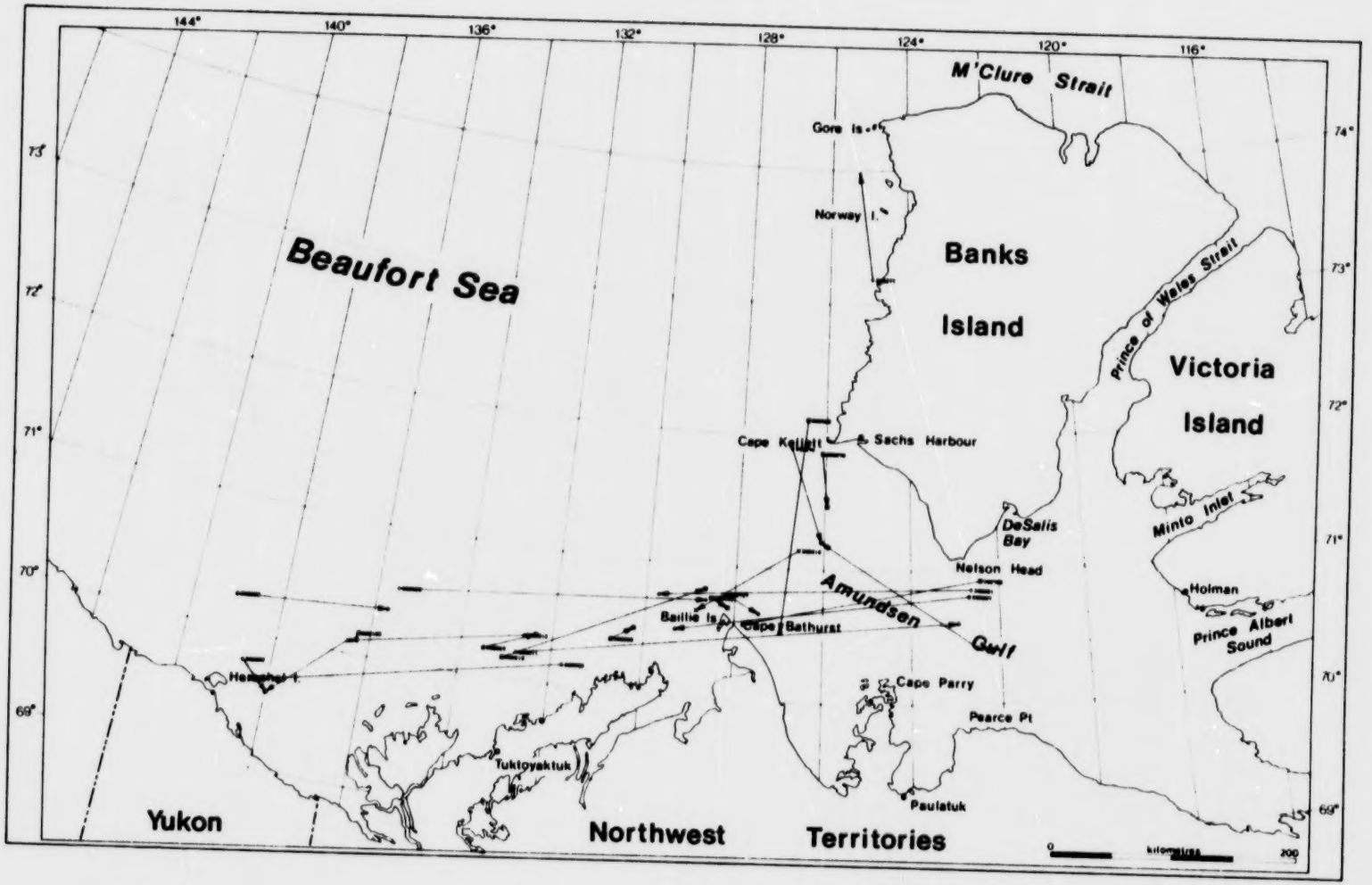

Figure 4. Movements of polar bears captured in 1985 and recaptured in 1986.